Remarks

Thorough examination by the Examiner is noted and appreciated.

The claims have not been amended.

No new matter has been added.

Claim Rejections under 35 USC 103(a)

1. Claims 1-14, 17-20, 22-26, 29, 42-48, 51, and 52 stand rejected under 35 USC Section 103(a) as being unpatentable over Lin ('448) (US 6,342,448) in view of Liu et al. (US 6,037,258) and Lin ('158) (US 6,297,158).

Lin ('448) disclose a method for forming an improved TaN barrier layer. Lin ('448) disclose forming a first Ta layer followed by a middle TaN layer followed by an upper Ta layer (see Abstract). Lin ('448) teach that the upper Ta layer (18 to 22 Angstroms thick) improves wetting of an overlying copper seed layer (see e.g., col 9, lines 8-25). Lin ('448) disclose CVD or sputtering of a single copper seed layer over the Ta barrier

layer (see col 5, lines 52-64).

Examiner now admits that Lin ('448) do not disclose several aspects of Applicants disclosed and claimed invention including those elements in **bold type**.

Nowhere does Lin ('448) disclose or suggest:

"forming a diffusion barrier layer to line the damascene opening;

then **forming a first seed layer** on the diffusion barrier;

then plasma treating the first seed layer in-situ with a first treatment plasma, said **first treatment plasma formed from plasma source gases** selected from the group consisting of argon, nitrogen, hydrogen, and NH_3;

then forming a second seed layer on the first seed layer;"

On the other hand, Liu et al. disclose a three step copper seed layer **PVD deposition process** where the first step is PVD

depositing about half the thickness of the copper seed layer (500 to 1200 Angstroms (col 4, lines 29-45); the **second step is a cool down procedure accomplished by purging the front and backside of the wafer with argon** (not an argon plasma) (col 4, lines 46-54); the third step is PVD depositing the remaining thickness of the copper seed layer (total thickness from 800 to 2500 Angstroms) (col 4, lines 8-10; lines 57-65). Liu et al. teach that the cool down process allows excessive temperatures to be avoided caused by plasma bombardment in the PVD process, thus resulting in a rough topography surface (Abstract; col 2, lines 1-15; col 4, lines 60-65). Liu et al. disclose a second embodiment where the argon purge (cooling) process is carried out in a separate cool down chamber (col 5, lines 23-37).

Examiner is clearly mistaken in alleging that Liu et al. disclose an argon plasma treatment. It is clear the argon gas purge process of the front and backside of the wafer to cool the wafer to room temperature is not a plasma treatment **(there is no plasma formed in the argon purge treatment of Liu et al.)**.

With respect to claims 18 and 46, Liu et al. further nowhere disclose forming a second seed layer on the first seed layer following the first plasma treatment and then plasma treating the second seed layer.

Examiner is clearly mistaken in alleging that Liu et al. disclose plasma treating a second seed layer. Even assuming, arguendo, that the second half of the seed layer of Liu et al. can be interpreted as a second seed layer, Liu et al. nowhere disclose or suggest plasma treating, or argon purging (cooling) the second half of the seed layer. Liu et al. disclose carrying out an electrochemical deposition process to fill a dual damascene opening **following PVD depositing the second half of the seed layer** (col 4, line 65 - col 5, line 5).

The fact that Lin (158) discloses that electro-chemical plating is also known as electro-chemical deposition, does not further help Examiner.

Thus, even assuming arguendo, a proper motivation for combining the references, such combination does not produce or suggest Applicants invention.

"**First**, there must be some **suggestion or motivation**, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. **Second**, there must be a **reasonable expectation of success**. **Finally**, the prior art

reference (or references when combined) **must teach or suggest all the claim limitations**. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)*.

With respect to claims 2 and 3, Liu et al. nowhere discuss and one cannot infer from the Figures "wherein at least one of the first and second seed layers forms a continuous layer over active areas of the substrate."

With respect to claims 4 and 5, Liu et al. nowhere discuss whether deposition by a PVD process results in a conformal or non-conformal seed layer. Examiner statement that "one skilled in the art would readily recognize" that having a first or second non-conformal seed layer "would exist at some level of deposition of the material which would be improved by the deposition of the second seed layer that". Examiner cites no support for the assertion which appears to be an inherency argument, which Applicants reject.

"The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the

inherency of that result or characteristic." *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ (Fed. Cir. 1993).

"To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill." *In re Oelrich, 666 F.2d 578, 581-582, 212 USPQ 323, 326 (CCPA 1981).*

With respect to claims 6 and 19, the fact that Lin('448) discloses that a single seed layer may be deposited by PVD or CVD, where Liu et al. specifically teach two PVD processes for depositing a first half and a second half of a seed layer, does not further help Examiner.

With respect to claims 7-9 and claims 20-22, the fact that Examiner now refers to Liu for the teaching that the first and second halves of the seed layer are deposited by a PVD process does not help Examiner produce Applicants claims.

With respect to claims 17 and 29, the fact that Lin('448) disclose a barrier layer by forming a first Ta layer followed by a middle TaN layer followed by an upper Ta layer, and a copper seed layer on the Ta upper layer, (see Abstract) does not help Examiner.

With respect to claim 51, Liu nowhere disclose or suggest that the dual PVD cooper seed layer process of (where the cool down process may be carried out in a second chamber, would produce Applicants invention "wherein the first and second seed layers are substantially oxide free prior to deposition of the copper layer." Since Liu et al nowhere discuss this, Examiners assertion amounts to an inherency argument, which Applicants reject.

2. Claims 15, 16, 27, 28, 49, and 50 stand rejected under 35 USC Section 103(a) as being unpatentable over Lin ('448) (in view of Liu et al. and Lin ('158), above, and further in view of Chung et al. (2003/0057526).

Applicants reiterate the comments made above with respect to Lin ('448) (in view of Liu et al. and Lin ('158).

On the other hand, Chung et al. disclose a method of forming a barrier layer with a seed layer that may comprise a plurality of seed layer including **first copper alloy seed layer** and a **second undoped copper seed layer** (paragraph 0061) to improve adhesion of a copper seed layer to an underlying barrier layer and to prevent dewetting of the copper seed layer by agglomeration in subsequent thermal processes (see Abstract; col

1, paragraph 008; paragraph 0059; paragraph 0061; paragraphs 0068-0070; claims 1, 8, an 17). Chung et al. disclose **plasma annealing** a **TaN barrier layer prior to depositing a seed layer** (see paragraph 0047). Chung discloses that **"any suitable technique to deposit the seed layer may be used"** including PVD, CVD, electroless deposition or a combination of techniques.

The further fact that Chung disclose that the first and second copper seed layers have a combined thickness of 10 Angstroms to 200 Angstroms in the field areas, preferably between about 500 Angstroms and 1000 Angstroms for a first and second layer deposited by a PVD process, and where the first and second seed layers may have the same thickness, or the first seed layer may be less than 50 Angstroms (paragraphs 0060,0061, 0062,0064) does not further help Examiner in producing Applicants invention.

"**First**, there must be some **suggestion or motivation**, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. **Second**, there must be a **reasonable expectation of success**. **Finally**, the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. The teaching or suggestion to make the

claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).*

Conclusion

The cited combination of references fails to produce or suggest Applicants disclosed and claimed invention, and is therefore insufficient to make out a *prima facie* case of obviousness with respect to Applicants independent and dependent claims.

Based on the foregoing, Applicants respectfully request favorable consideration of the claims and submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

U.S.S.N. 10,723,509

Respectfully submitted,

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